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(71) Applicant: NEC CORPORATION  
Tokyo (JP)

(72) Inventors:  
• Fan, Ruixue  
Princeton, NJ 08540 (US)

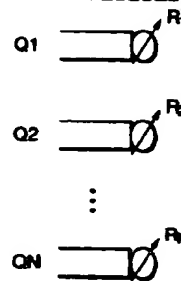
• Mark, Brian  
Princeton, NJ 08540 (US)  
• Ramamurthy, Gopalakrishnan  
Princeton, NJ 08540 (US)

(74) Representative:  
Baronetzky, Klaus, Dipl.-Ing.  
Splanemann Reitzner  
Baronetzky Westendorf  
Patentanwälte  
Rumfordstrasse 7  
80469 München (DE)

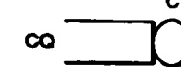
### (54) Dynamic rate control scheduler for ATM networks

(57) A Dynamic Rate Control (DRC) scheduler for scheduling cells for service in a generic Asynchronous Transfer Mode (ATM) switch is disclosed. According to the inventive DRC, each traffic stream associated with an internal switch queue is rate-shaped according to a rate which consists of a minimum guaranteed rate and a dynamic component computed based on congestion information within the switch. While achieving high utilization, DRC guarantees a minimum throughput for each stream and fairly distributes unused bandwidth. The distribution of unused bandwidth in DRC can be assigned flexibly, i.e., the unused bandwidth need not be shared in proportion to the minimum throughput guarantees, as in weighted fair share schedulers. Moreover, an effective closed-loop QoS control can be built into DRC by dynamically updating a set of weights based on observed QoS. Another salient feature of DRC is its ability to control congestion internal congestion at bottleneck points within a multistage switch. DRC can also be extended beyond the local switch in a hop-by-hop fashion.

#### STREAM QUEUES



#### BOTTLE QUEUE



$$R_i = M_i + E_i$$

$R_i$  = DYNAMIC GUARANTEED RATE

$M_i$  = MINIMUM GUARANTEED RATE

$E_i$  = DRC RATE

Fig.2

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# EUROPEAN SEARCH REPORT

Application Number  
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DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.CL6)
X	WO 95 03657 A (WATANABE NAOTOSHI ;FUJITSU LTD (JP); HATANO TAKASHI (JP); KAKUMA S) 2 February 1995 (1995-02-02) * abstract *	1-6	H04Q11/04 H04L12/56
A	---	9-13, 16-25,28	
A	US 5 274 644 A (BERGER ARTHUR W ET AL) 28 December 1993 (1993-12-28) * claim 1 *	1-7, 9-13, 16-29	
A	---		
A	EP 0 705 007 A (ROKE MANOR RESEARCH) 3 April 1996 (1996-04-03) * claims 1,2 *	1-7, 9-13, 16-29	
X	EP 0 661 851 A (NIPPON ELECTRIC CO) 5 July 1995 (1995-07-05) * column 2, line 26 - line 56 *	8,14	
A	---	15	
			TECHNICAL FIELDS SEARCHED (Int.CL6)
			H04L H04Q
The present search report has been drawn up for all claims			
Place of search <b>THE HAGUE</b>		Date of completion of the search <b>9 May 2000</b>	Examiner <b>Veen, G</b>
<p><b>CATEGORY OF CITED DOCUMENTS</b></p> <p>X : particularly relevant if taken alone  Y : particularly relevant if combined with another document of the same category  A : technological background  O : non-written disclosure  P : intermediate document</p> <p>T : theory or principle underlying the invention  E : earlier patent document, but published on, or after the filing date  D : document cited in the application  L : document cited for other reasons  &amp; : member of the same patent family, corresponding document</p>			

EPO FORM 1503 03/82 (P4/001)

**ANNEX TO THE EUROPEAN SEARCH REPORT  
ON EUROPEAN PATENT APPLICATION NO.**

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This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.  
The members are as contained in the European Patent Office EDP file on  
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09-05-2000

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### CLAIMS INCURRING FEES

The present European patent application comprised at the time of filing more than ten claims.

- ☐ Only part of the claims have been paid within the prescribed time limit. The present European search report has been drawn up for the first ten claims and for those claims for which claims fees have been paid, namely claim(s):
- ☐ No claims fees have been paid within the prescribed time limit. The present European search report has been drawn up for the first ten claims.

### LACK OF UNITY OF INVENTION

The Search Division considers that the present European patent application does not comply with the requirements of unity of invention and relates to several inventions or groups of inventions, namely:

see sheet B

- ☒ All further search fees have been paid within the fixed time limit. The present European search report has been drawn up for all claims.
- ☐ As all searchable claims could be searched without effort justifying an additional fee, the Search Division did not invite payment of any additional fee.
- ☐ Only part of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the inventions in respect of which search fees have been paid, namely claims:
- ☐ None of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the invention first mentioned in the claims, namely claims:



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**LACK OF UNITY OF INVENTION  
SHEET B**

Application Number  
**EP 98 10 7928**

The Search Division considers that the present European patent application does not comply with the requirements of unity of invention and relates to several inventions or groups of inventions, namely:

**1. Claims: 1-7, 9-13, 16-29**

Scheduling method assigning to each queue a guaranteed minimum rate plus a variable excess rate.

**2. Claims: 8, 14, 15**

Shaping method wherein the transmission rate is reduced to a minimum when a buffer level reaches a first threshold, and to zero when it reaches a second threshold.

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